NON-PROVISIONAL APPLICATION FOR UNITED STATES PATENT

FOR

# Air Grate

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## FIELD OF THE INVENTION

**[0001]** The present invention relates generally to the field of integrated circuits, in particular, an air grate for integrated circuit manufacturing.

## BACKGROUND OF THE INVENTION

**[0002]** Integrated circuit or semiconductor device manufacturing factories may be divided into the bay/chase type and the flow-through type. In a bay/chase fab, cleanroom air is re-circulated downward from filters in the factory ceiling into the "bay" (where the front of semiconductor wafer process equipment is located), then through a raised metal floor deck exhausted back into the plenum via the "chase". Bays and chases are separated via hard walls to segregate the air flow. In a flow-through fab, clean air passes through filters in the ceiling and flows downward through the raised metal floor deck, through openings (also called popouts) in the fab level concrete floor, and into the subfab, where it is re-circulated back into the plenum.

**[0003]** Since all air flows in a flow-through fab are downward at the fab level, no walls are required to segregate airflows, allowing the process equipment to be packed more densely. It has been estimated that a flow-through fab is about 15% more efficient (in terms of space utilization) than bay/chase fabs.

**[0004]** However, these air flow holes of flow-through fabs raise a number of safety issues, e.g. 1) items may be dropped from the fab level onto people working the subfab, and 2) fab level spills may migrate into the sub-fab, complicating clean up and, in serious cases, damaging support equipment in the sub-fab. Further, in severe situations, output may suffer due to loss of production equipment.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0005]** The present invention will be described by way of exemplary embodiments, but not limitations, illustrated in the accompanying drawings in which like references denote similar elements, and in which:

**[0006]** **Figures 1a-1c** illustrate a top view, a side view and a cross-sectional view of an air grate suitable for use to partially cover a fab level air flow opening, in accordance with one embodiment of the present invention;

**[0007]** **Figure 2** illustrates a cross-sectional view of the air grate installed at an example fab level air flow opening; and

**[0008]** **Figure 3** illustrates a process for making the air grate of **Figure 1**, in accordance with one embodiment.

## DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

**[0009]** Illustrative embodiments of the present invention include, but are not limited to an air grate, suitable for use to partially cover a fab level air flow opening of a flow-through fab.

**[0010]** Various aspects of the illustrative embodiments will be described using terms commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art. However, it will be apparent to those skilled in the art that the present invention may be practiced with only some of the described aspects. For purposes of explanation, specific numbers, materials, and configurations are set forth in order to provide a thorough understanding of the illustrative embodiments. However, it will be apparent to one skilled in the art that the present invention may be practiced without the specific details. In other instances, well-known features are omitted or simplified in order not to obscure the illustrative embodiments.

**[0011]** The phrase "in one embodiment" is used repeatedly. The phrase generally does not refer to the same embodiment; however, it may. The terms "comprising", "having" and "including" are synonymous, unless the context dictates otherwise.

**[0012]** Referring now to **Figures 1a-1c**, wherein a top view, a side view and a cross-sectional view of an air grate suitable for use to cover a fab level air flow opening, in accordance with one embodiment, are shown. More specifically, **Figure 1c** is a cross sectional view of the air grate taken at axis X-X of **Figure 1a**.

**[0013]** As will be described in more detail below, for the embodiment, air grate **100** is designed to simultaneously meet

**[0014]** a) a semiconductor device manufacturing air flow requirement;

**[0015]** b) a semiconductor device manufacturing fall through object size limitation;

**[0016]** c) a semiconductor device manufacturing weight drop requirement; and

**[0017]** d) a semiconductor device manufacturing spill protection requirement.

**[0018]** In alternate embodiments, air grate **100** may simultaneously meet more or less semiconductor device manufacturing requirements. For examples, only (a), (b) and (c), but not (d), or only (b) and (d), but not (a) and (c), and so forth.

**[0019]** In various embodiments, air grate **100** is a single molded piece, made of aluminum. In alternate embodiments, air grate **100** may be formed by joining multiple pieces of one or more materials together. The one or more materials may be joined by fastening, welding and so forth. The one or more materials may be other metals with appropriate tensile strength, such as iron, steel and so forth. In yet other embodiments, the one or more materials may be alloys or non-metallic materials.

**[0020]** As illustrated, the one or more pieces of one or more materials are adapted to partially cover a spanned area to meet the air flow requirement for a fab level air flow opening. An example of such fab level air flow opening is illustrated as element **200** of **Figure 2**.

**[0021]** Continuing to refer to **Figures 1a-1c**, the exact amount of air flow required by a fab level air flow opening is application dependent, i.e. fab specific. For the embodiment, air grate **100** is adapted to meet the air flow requirement of a fab level air flow opening through a number of openings **102** disposed in 60 or more percents of the spanned area. That is, for the embodiment, air grate **100** partially covers 40 or less percents of the fab level air flow opening.

**[0022]** In various embodiments, the spanned area is a circular area with a diameter of about 15 inches. In other embodiments, the spanned area may be larger or smaller, as well as having other geometric shapes, including but not limited to a rectangle shape, a polygon shape, an octagon shape, and so forth.

**[0023]** For the embodiments, openings **102** are arranged in a substantially row and column manner. In alternate embodiments, openings **102** may be arranged in other configurations.

**[0024]** Further, in various embodiments, each of the openings **102** is designed to meet an object fall thorough size limitation. More specifically, each of the openings **102** is designed to meet an object fall thorough size limitation of about 1 inch. That is, objects with sizes larger than 1 inch will not be able to fall through the fab level air flow opening into the sub-fab level. In other embodiments, each of the openings may be designed to

meet smaller or larger object fall through size limitations. Moreover, different openings **102** may be designed to meet different fall through object size requirements.

**[0025]** Still referring to **Figures 1a-1c**, for the embodiment, air grate **100** is also designed to meet a weight drop requirement. More specifically, for the embodiment, ribs **104** (employed to arrange openings **102** in a substantially row and column manner) are designed to have a thickness of about 1.0 inch to meet a weight drop requirement of 300 lbs from 2 feet above air grate **100**. In alternate embodiments, air grate **100** may be designed with rib **104** being thinner or thicker to meet lighter or heavier weight drop requirement of lower or heavier weights from a lower or higher distance above air grate **100**.

**[0026]** Referring now also to **Figure 2**, where air grate **100** installed is shown installed in a fab level air flow opening **200** from a cross-sectional view. As illustrated, fab level air flow opening **200** is defined by the separation between two fab level floor slab walls **202**. For the embodiment, each of the slab walls **202** include flanges **204** for the seating of air grate **100**.

**[0027]** For the embodiment, air grate **100** is designed to allow it to have a raised height of about 0.5 inch above the fab level floor for spill protection, after air grate **100** has been installed, i.e. seated on flanges **204** of fab level air flow opening **200**. In alternate embodiments, depending on the spill requirement and safety considerations, air grate **100** may be designed to have a lower or higher post-installation raised height.

**[0028]** Further, to improve spill prevention effectiveness, for the embodiment, air grate **100** is designed with an inwardly inclined non-straight side edge **106**. In alternate embodiments, air grate **100** may be designed with other non-straight or straight edges.

**[0029]** Additionally, for the embodiment, upon seating of air grate **100** on flanges **204** of fab level air flow opening **200**, a sealant **206** is applied to seal any remaining gap at the seat between air grate **100** and flanges **204**. Any one of a number of sealants may be employed.

**[0030]** **Figure 3** illustrates a process for making air grate **100** in accordance with one embodiment. As shown, for the embodiment, an air grate mold for creating an air grate that meets a number of semiconductor device manufacturing requirements is made, block

**302**. The semiconductor device manufacturing requirements may be one or more of the earlier described requirements, such as the earlier described air flow, fall through object size, weight drop and spill protection requirements, or other requirements of the like. The mold may be made in any one of a number of mold making techniques, which may be dependent on the materials to be employed to make air grate **100**.

**[0031]** At block **304**, molding material to make air grate **100** is injected into the mold. Then, at a later point in time, after allowing the injected materials to properly settle, air grate **100** is removed from the mold, block **306**. Air grate **100** may be removed from the mold in any one of a number of manners, including but not limited to breaking the mold.

**[0032]** Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent implementations may be substituted for the specific embodiments shown and described, without departing from the scope of the present invention. This application is intended to cover any adaptations or variations of the embodiments discussed herein. Therefore, it is manifestly intended that this invention be limited only by the claims and the equivalents thereof.